POLYPROPYLENE FIBER-REINFORCED MICROSILICA CONCRETE BRIDGE DECK OVERLAY AT LINK RIVER BRIDGE

Final Report

Experimental Features Project 98-01

by

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16. Abstract

In 1997 ODOT overlaid the Link River Bridge with microsilica concrete, reinforced with polypropylene fibers (FMC). The manufacturer claimed the fibers would reduce plastic shrinkage cracks and settlement cracking during the early life of the concrete, as well as reduce the formation of intrinsic cracking. The northbound lane was constructed with the FMC while the southbound lanes were constructed with plain microsilica concrete. Neither side showed much initial cracking when the curing blankets were removed. The latest inspection two years after construction found only minor cracking in the northbound lane and very little in the southbound lanes.

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SI* (MODERN METRIC) CONVERSION FACTORS

APPROXIMATE CONVERSIONS TO SI UNITS

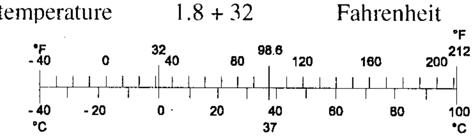
Symbol	When You Know	Multiply By	To Find	Symbol
		LENGTH		
in	Inches	25.4	millimeters	mm
ft	Feet	0.305	meters	m
yd	Yards	0.914	meters	m
mi	Miles	1.61	kilometers	km
		AREA		
in^2	square inches	645.2	millimeters squared	mm^2
ft^2	square feet	0.093	meters squared	m^2
yd^2	square yards	0.836	meters squared	m^2
ac	Acres	0.405	hectares	ha
mi^2	square miles	2.59	kilometers squared	km^2
		VOLUME		
fl oz	fluid ounces	29.57	milliliters	mL
gal	Gallons	3.785	liters	L
ft^3	cubic feet	0.028	meters cubed	m^3
yd^3	cubic yards	0.765	meters cubed	m^3

NOTE: Volumes greater than 1000 L shall be shown in m^3.

Symbol	When You Know	Multiply By	To Find	Symbol
		MASS		
oz	Ounces	28.35	grams	g
lb	Pounds	0.454	kilograms	kg
T	short tons (2000 lb)	0.907	megagrams	Mg
		TEMPERATURE (exact)		
°F	Fahrenheit temperature	5(F-32)/9	Celsius temperature	°C

APPROXIMATE CONVERSIONS FROM SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
		LENGTH		
mm	millimeters	0.039	inches	in
m	meters	3.28	feet	ft
m	meters	1.09	yards	yd
km	kilometers	0.621	miles	mi
		AREA		
mm^2	millimeters squared	0.0016	square inches	in^2
m^2	meters squared	10.764	square feet	ft^2
ha	hectares	2.47	acres	ac
km^2	kilometers squared	0.386	square miles	mi^2
		VOLUME		
mL	milliliters	0.034	fluid ounces	fl oz
L	liters	0.264	gallons	gal
m^3	meters cubed	35.315	cubic feet	ft^3
m^3	meters cubed	1.308	cubic yards	yd^3
		MASS		
g	grams	0.035	ounces	oz
kg	kilograms	2.205	pounds	lb
Mg	megagrams	1.102	short tons (2000 lb)	T
		TEMPERATURE (exact)		
°C	Celsius temperature	1.8 + 32	Fahrenheit	°F



* SI is the symbol for the International System of Measurement

(4-7-94 jbp)

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POLYPROPYLENE FIBER-REINFORCED MICROSILICA CONCRETE BRIDGE DECK OVERLAY AT LINK RIVER

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1.0 INTRODUCTION

The Oregon Department of Transportation (ODOT) began using microsilica concrete for bridge deck overlays in 1989. Since then, over 50 bridge decks have been overlaid with microsilica concrete. Many of these overlays developed cracks after placement. In 1997 ODOT overlaid the Link River Bridge with microsilica concrete, reinforced with polypropylene fibers (FMC). The manufacturer claimed the fibers would reduce plastic shrinkage cracks and settlement cracking during the early life of the concrete, as well as reduce the formation of intrinsic cracking. This report documents the construction and two-year evaluation of the bridge deck.

Research has been done in Oregon on the evaluation of premature cracking and delamination on latex and microsilica bridge decks. The "Latex and Microsilica Modified Concrete Bridge Deck Overlays in Oregon, Interim Report" (*Lundy 1995*) described the results of seven microsilica overlay inspections one year after construction. Very fine cracking was found on all bridges in a random pattern. The cracks occurred principally during the first few weeks after placement. In addition, other states have reported cracking on all their deck overlays. Early cracking was related to plastic and drying shrinkage. These cracks can propagate through the overlay and permit contaminated water to reach the deck. Control of this cracking is needed.

1.1 STUDY OBJECTIVE

The objective of this project was to investigate the use of polypropylene fibers in microsilica concrete to reduce early cracking and inhibit later crack growth. The fibers used were manufactured by the Fibermesh Company of Chattanooga, Tennessee. Steel fibers had been used on a few overlays in Oregon but the polypropylene fibers had not. Other states had used these fibers, but no reports were available on their performance at the time of this study.

2.0 PROJECT DESCRIPTION

2.1 PROJECT LOCATION AND ENVIRONMENT

The fiber reinforced microsilica concrete (FMC) overlay was placed on the Link River Bridge, located on U.S. 97 near Klamath Falls, Oregon (Bridge #8347, on Hwy. 4 at milepost 275.03). Figures 2.1 and 2.2 show the vicinity and location. The bridge includes seventeen spans. The total length is 359 m and the width is about 9 m. The bridge has spans of both reinforced concrete deck girders and steel deck girders. A plan view of the bridge is included in the Appendix.

The site elevation of 1,251 m can produce some harsh winters with ice, snow and temperatures of -15 °C. Summers are typically hot and dry. Both seasonal conditions cause wear on bridge decks. In winter, tire chains and studded tires on cars cause extensive bridge deck wear. Summer heat causes expansion joints to butt against each other and place extra stresses in the deck surface.

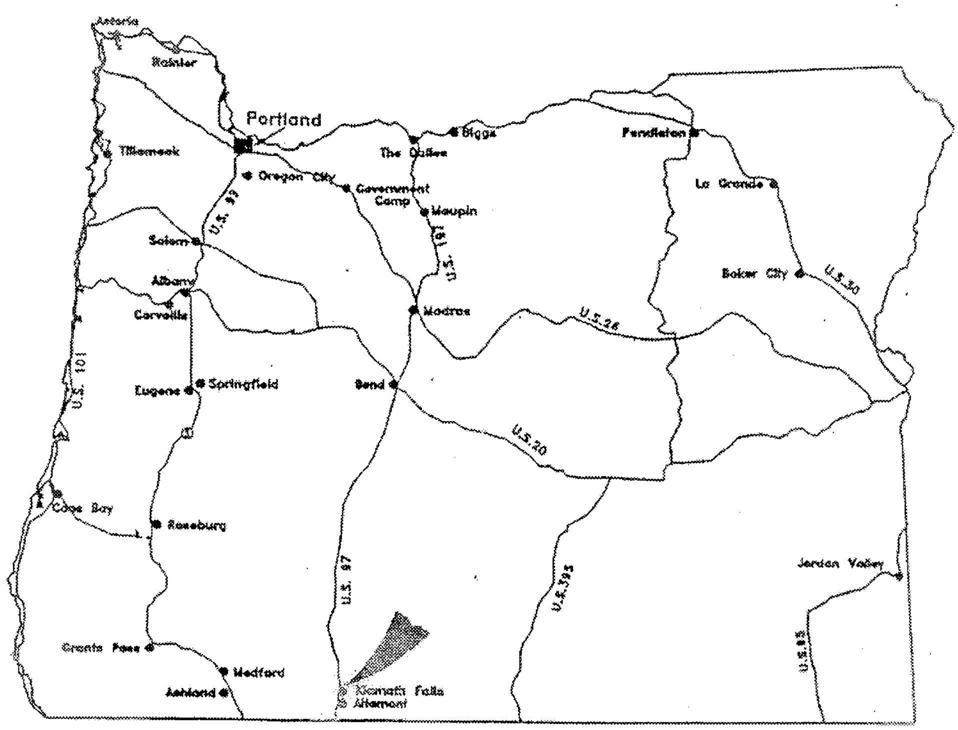

Figure 2.1: Project vicinity map

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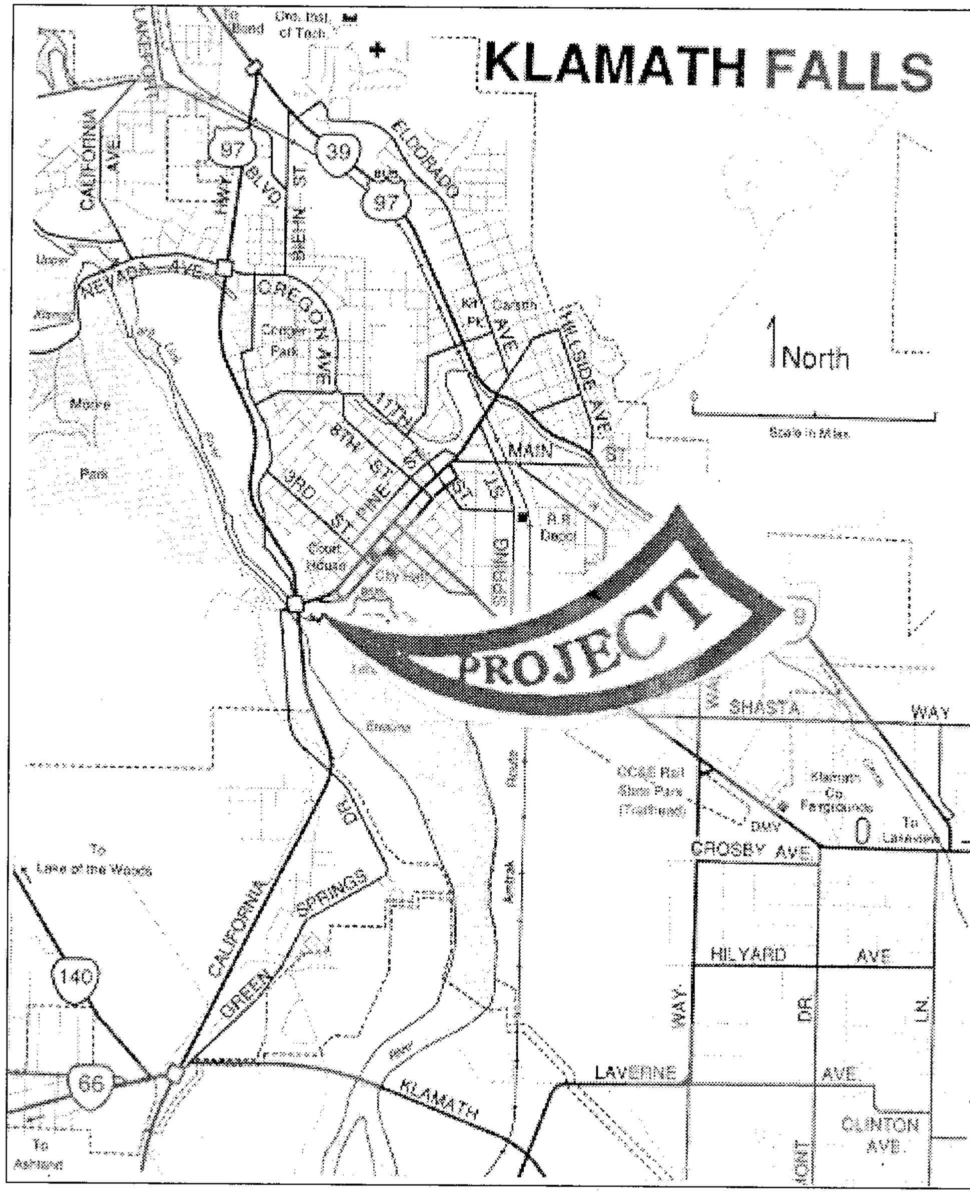

Figure 2.2: Project location map

3.0 CONSTRUCTION

The Link River Bridge deck rehabilitation was part of a larger project, which involved work on other structures. Because the bridge was to remain open for traffic, stage construction was used. Traffic was regulated to one lane by means of a traffic signal. The lane adjacent to the pour carried all the traffic.

The northbound lane with the fibers was completed first. The work was done in two pours: June 18 and 20, 1997. The southbound lane was done about a month later. This work was done in five pours: July 29, August 1, August 6, August 8, and August 15, 1997.

All work was done at night or early morning to minimize evaporation effects on the initial cure of the deck. Table 3.1 includes the details of the weather conditions during construction. For the northbound lane construction, the fibers were added to the mix at the concrete batch plant and were completely mixed upon arrival at the site. The project inspector noted that the fibers made the concrete easier to place and finish. The fibers in the mix increased the stiffness. Because of this stiffness, the mix was easier to handle on the superelevation of the deck and especially on the southbound off-ramp.

Table 3.1: Average Weather Conditions for Deck Pours

	Date (1997)	Start Time	Air Temperature, °C	Relative Humidity, %	Wind speed, km/hr	Evaporation[2], kg/m²/hr
Northbound Lane	June 18	4:15 am	12.8	68	0	0.12
	June 20	3:20 am	5.6 [1]	87	0	0.07
Southbound Lane	July 29	3:10 am	16.7	72	1	0.15
	Aug 1	4:50 am	11.1	96	0	0.05
	Aug 6	5:20 am	16.7	85	0	0.05
	Aug 8	4:30 am	17.2	69	3	0.27
	Aug 15	3:40 am	12.8	71	0	0.08

[1] The lowest temperature during this pour was 3 °C.
[2] The specification limit is 0.73 kg/m²/hr.

4.0 EVALUATIONS

The project inspector observed the deck condition when the curing blankets were removed. Both the northbound and southbound lanes had about the same amount of micro cracking. Table 4.1 shows the types of cracking found after the cure blankets were removed.

Table 4.1: Cracking Noted after Curing

Span	Northbound Lane	Southbound Lane
1	0.61 m long, north end	
2	0.61 m long, 9.1 m from north end	
3	No cracks	
4	No cracks	
5	No cracks	
6	No cracks	
7	Hairline 6.1 m long, 3.1 m from gutter	
8		
9	Hairline	
10	Hairline	
11		No cracks
12		No cracks
13		Under traffic
14		No cracks
15		No cracks
16		No cracks
17	Hairline	Cracks south end to first joint

The record is incomplete because some of the curing blankets had not been removed at the time of the inspection. The inspector's best recollection is that the northbound and southbound lanes had about the same amount of initial cracking.

4.1 POST CONSTRUCTION INSPECTION

The deck was inspected about two years after the deck pour. Cracking was found in both lanes, with the majority in the northbound lanes constructed with the FMC. Figure 4.1 shows the typical cracking found in the northbound lane, while figure 4.2 shows the typical crack-free southbound lane.

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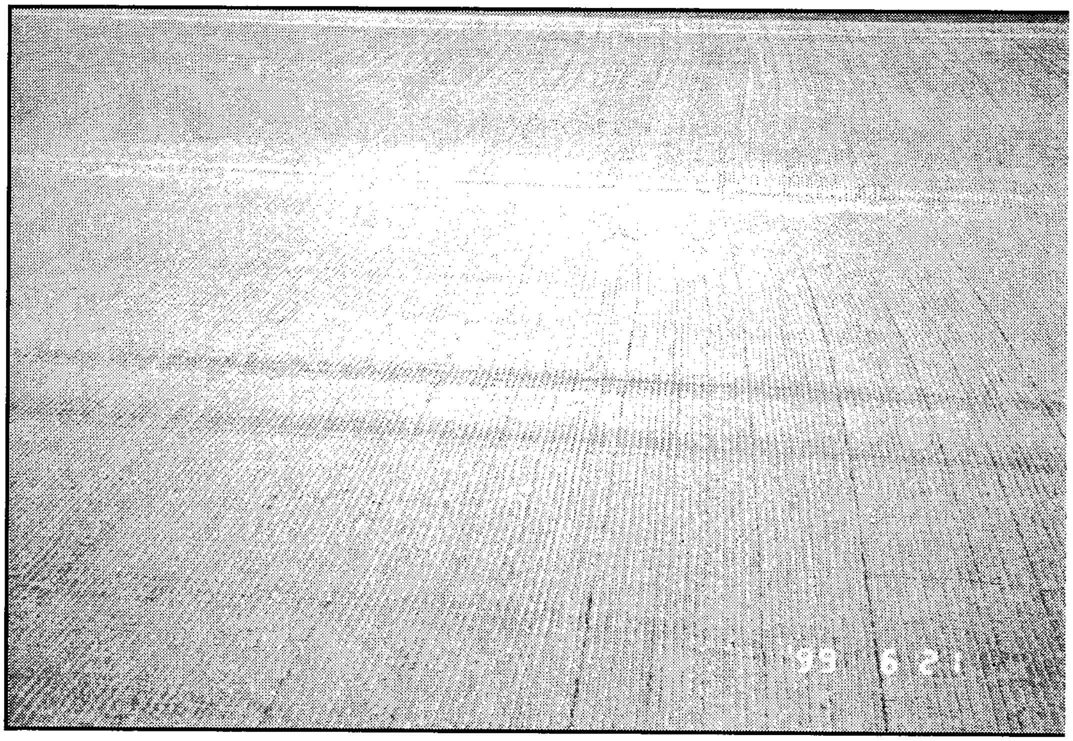

Figure 4.1: Typical cracking in northbound lane two years after construction.

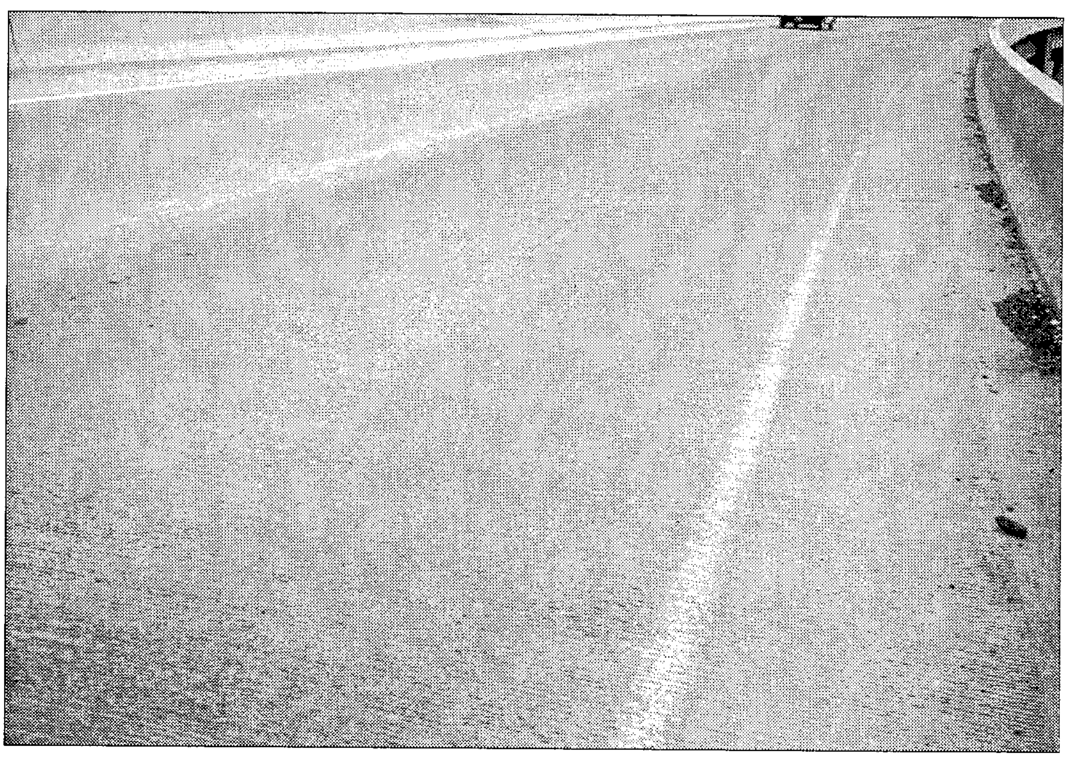

Figure 4.2: No large cracks were found in the southbound lane.

5.0 CONCLUSIONS

Cracking resistance was found to be no better in the northbound lane with fibers, compared to the southbound lane without fibers. Cracking was also observed in both lanes two years after construction. Thus the vendor's claim of reducing cracking on both the short term and long term was not supported.

Placement during optimal weather conditions (no wind, cool temperatures, and fairly high humidity) – resulting in low evaporation rates – is probably the most significant factor in keeping the amount of cracking low. In addition, curing blankets were placed promptly after tining. It is not clear from this project whether fibers can make up for poor placement and curing conditions, but it is clear that they are not needed if placement and curing is done well.

6.0 REFERENCES

Lundy, James R. and Suvimol Sujjavanich. *Latex and Microsilica Modified Concrete Bridge Deck Overlays in Oregon: Interim Report.* Oregon Department of Transportation, Research Group. January 1995.

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APPENDIX: LINK RIVER BRIDGE PLAN VIEW

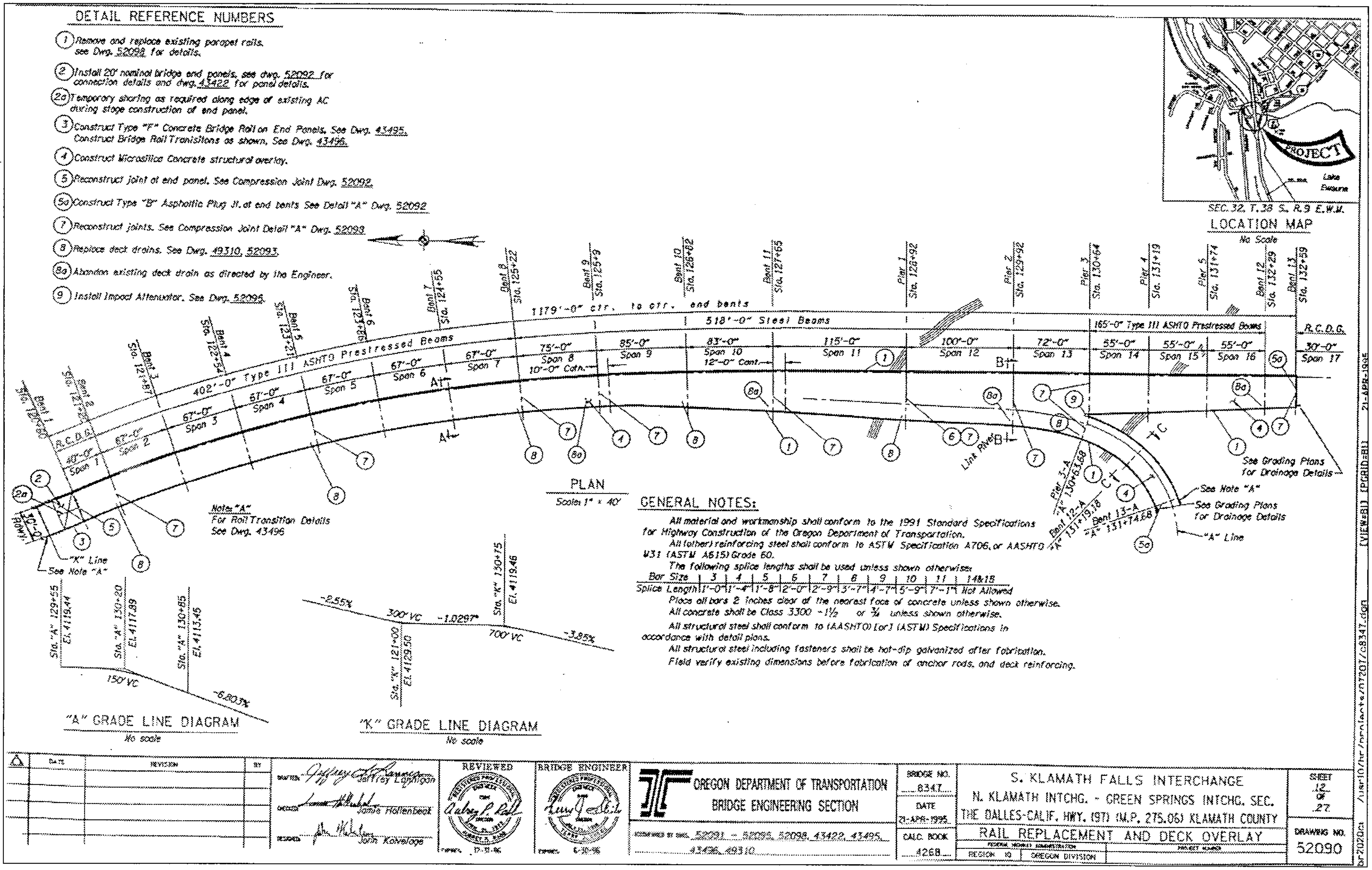

Figure A-1: Link River Bridge plan view